(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 886 362 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.12.1998 Bulletin 1998/52

(51) Int. Cl.[6]: **H02J 13/00**, H02J 3/14

(21) Application number: **98114424.9**

(22) Date of filing: **09.03.1993**

(84) Designated Contracting States:
DE FR GB

(30) Priority: **10.03.1992 JP 51941/92**
30.03.1992 JP 74634/92

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
93103755.0 / 0 561 255

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Remarks:
This application was filed on 31 - 07 - 1998 as a divisional application to the application mentioned under INID code 62.

(54) Power distribution control system

(57) The present invention relates to a power distribution control system which includes a center communication terminal (S) and a plurality of customer's communication terminals (C1,...,Cn) operatively connected to the center communication terminal through communication lines. Each of the customer's communication terminals is responsive to a presentation signal from the center communication terminal for outputting a response signal to the center communication terminal. The center communication terminal also provides a response signal to the respective one of the customer's communication terminals.

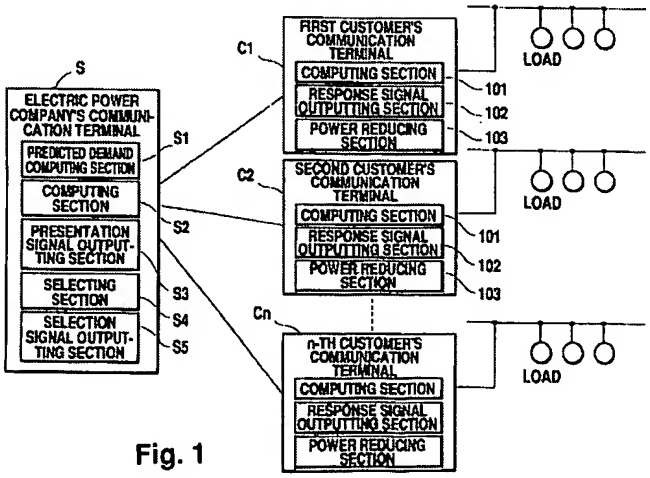


Fig. 1

EP 0 886 362 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a power distribution control system for distributing an electric power by transmitting and receiving signals between the terminal of an electric power company and the terminals of houses, factories and the like.

Description of the Related Art:

Energy produced in the power plant of an electric power company is mainly distributet to houses, factories and others. In recent years, the power consumption has greatly changed throughout the year. In general, the power consumption is on peak in the summer daytime while it is off peak in the winter nighttime. The power installation is constructed to cope with the on-peak power consumption.

As the power demand in typical houses increases with the spread of air conditioner, the difference between on-peak and off-peak energy consumption increases. As a result, the annually averaged load or annual load factor for the service capability gradually decreases. The production cost is also increasing. Therefore, the leveling of loads is urgently required.

In order to accomplish the leveling, there has been proposed a system wherein the power supply to loads such as air conditioners is forcedly shut off depending on the need of the energy supplier, irrespective of the customers' needs. Instead incentive payments are paid back to the customers. For example, in U.S.A., the electric power company computes a tariff from an expected power consumption based on a predicted energy factor for a customer before one day. The computed tariff is one-sidedly reported from the electric power company to the customer. Such a system is called "spot tariff system".

Literature "Actual Proof and Test for concentrically Controlling Loads (Control of Air Conditioners)" in JEC, Convention of Electric Power and Energy Department, 1991 proposed a method for intermittently stopping the power supply to the air conditioners. Although such a method is effective to reduce the on-peak energy consumption, circumstances on the side of houses, factories and others will be completely ignored. Furthermore, the spot tariff system cannot provide a remarkably improved advantage since the predicted demand will not accurately reflect variations in demand due to variable weather. When the air conditioners are intermittently shut off, the leveling of all the loads cannot be effectively accomplished since the instruments to be controlled are limited to the air conditioners.

It is therefore an object of the present invention to provide a power distribution system which can properly distribute the electric energy and level the loads depending on variations of demand through time and circumstances of houses, factories and other customers.

SUMMARY OF THE INVENTION

According to the invention, in a power distribution control system comprising a center side communication terminal and customer side communication terminals, the electric power can be distributed to houses, factories and other customers to level the loads while considering the variable demand through time and the circumstances of the houses, factories and other customers. Particularly, since a customer makes a bid for the presentation from the center side which in turn makes a successful bid for the customer's bid, the optimum distribution can be made considering circumstances on both the center and customer sides.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of an electric power distribution system.

Fig. 2 is a view illustrating the operation of the power distribution system.

Fig. 3 is a block diagram of another electric power distribution system.

Fig. 4 is a block diagram of a still another electric power distribution system.

Fig.5 is a view illustrating the operation of the electric power distribution system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Fig 1, The power distribution control system, which is the first embodiment of the present invention, comprises an electric power company's communication terminal S or center communication terminal and a plurality of customer's communication terminals C1 to Cn connected to the center communication terminal through the respective communication lines. Each of the customer's communication terminals is connected to a corresponding load which has been installed in a house, factory or the like.

The center communication terminal S comprises a predicted demand calculating section S1 which is adapted to receive input signals relating to, for example, present demand (X1), season (X2), day of the week (X3), time (X4), air temperature (X5), event schedule (X6), possible audience rating (X7) and so on. Thus, a predicted demand U1 will be computed from a function U1=F1 (X1, X2, X3, X4, X5, X6, ...). The computation of the predicted demand may be carried out for periods of very thirty minutes.

The predicted demand is then compared with a power supply capacity to Judge whether or not it should

be considered to reduce the number of loads. Even if the predicted demand does not exceed the power supply capacity, there may be a case when it is desired to reduce the demand in place of the incentive payment without increase of the electric power generation having its critical cost. The critical cost may be computed from the predicted demand to judge whether or not it should be considered to reduce the number of loads. The incentive payment is a compensation returned back to a customer in place of the reduction of electric power level and proportional to the reduced quantity of electric power.

The center communication terminal S also comprises a computing section S2. When it should be considered to reduce the number of loads, the computing section S2 determines a time zone through which the predicted demand computed exceeds the power supply capacity to compute a load reduction time period and to determine the incentive payment level. The incentive payment depends on the critical cost, the past response from the customer and so on.

The center communication terminal further comprises a presentation signal outputting section or means S3 which outputs and sends a presentation signal including the load reduction time period and incentive payment to the respective one of the customer's communication terminals C1 to Cn, as shown in Fig. 2 .

When each of the customer's communication terminals C1 to Cn receives a presentation signal, its computing section 101 checks a potential of reduction resulting in a reduction factor considering the load reduction request time and the incentive payment. It is now judged whether or not the reduction of the supplied power is possible. If it is possible, the computing section 101 computes the quantity and time period of power to be reduced. The potential for reduction includes event and operation schedule (Xc1), reduction of air conditioner load (Xc2), running time shift in water heater (Xc3), partial stoppage of elevator (Xc4). partial lights-out (Xc5), partial stoppage of computer (Xc6), amount of loss due to partial shutdown of operations in a factory (Xc7) and so on. The potential of reduction Xc is computed from the above factors.

If there is a reduction of electric power, the reduced quantity of power U2 and the reduction time period U3 are computed from functions, U2=F2 (Xa, Xb and Xc) and U3=F3 (Xa, Xb and Xc), considering the load reduction request time period (Xa) and incentive payment (Xb) in the presentation signal and the computed potential of reduction (Xc). When the computing section 101 in each of the center communication terminals C1 to Cn computes the reduced amount of power and reduction time period, a response signal outputting section or means 102 outputs a tender signal functioning as a response signal containing the reduced amount of power and reduction time period to the center communication terminal S. A customer's communication terminal may decide not to output a tender signal depending on the contents of a presentation signal from the center communication terminal S.

When the center communication terminal S receives the tender signal, its selecting section S4 selects customers from the functions including parameters such as the reduction time period and reduced amount of power. For example, the selected customers may be any number of customers in the higher rank which has an increased product of the reduced amount of power times the reduction time period in each of the tender signals. Namely, a successful bid is made. After selection of the customers, a selection signal outputting section or means S5 in the center communication terminal S sends a successful bid signal as a selection signal including the reduced amount of power, the reduction time period and the incentive payment to each of the customer's communication terminals selected. As shown in Fig. 2 , for example, if the second customer's communication terminal C2 is selected, a successful bid signal is provided thereto. The reduced amount of power, the reduction time period and the incentive payment in the successful bid signal sent are computed from the reduced amount of power and reduction time period in the tender signal from each of the customer's communication terminals. A non-selection signal may be provided to the other customer's communication terminals which are not selected. The aforementioned successful bid signal may be a simple selection signal which does not include the reduced amount of power, the reduction time period and the incentive payment.

When each of the customer's communication terminals receives a successful bid signal, its power reducing section or means 103 reduces the power supply to the group of connected loads, in accodance with the reduced amount of power and reduction time period in the successful bid signal.

The present invention further provides the second embodiment which is different from the above embodiment in that the center communication terminal outputs a presentation signal including only the load reduction request time period and each of the customer's communication terminals computes an incentive wage from the load reduction request time period and the potential of reduction in the presentation signal. The center communication terminal then receives a tender signal as a response signal including the computed incentive payment and selects one or more customers which have a lower incentive payment than the other customers. Thus, the center communication terminal may send a successful bid signal as a selection signal to each of the selected customer's communication terminals.

As the third embodiment of the present invention, the center communication terminal may output a presentation signal containing only the load reduction request time period and each of the customer's communication terminals computes the reduced amount of power, the reduction time period and the incentive payment from the load reduction request time period and

the potential of reduction in the presentation signal. The center communication terminal then receives a tender signal from that customer's communication terminal, which is a response signal containing the computed reduced amount of power and reduction time period and the incentive payment and selects one or more customers from the functions having parameters such as the reduced amount of power and the reduction time period. Thus, the center communication terminal may send a successful bid signal as a selection signal to each of the customer's communication terminals.

In the fourth embodiment of the present invention, a plurality of customer's communication terminals D1 to Dn are connected to an electric power company's communication terminal or center communication terminal T, as in the first embodiment. The center communication terminal T comprises a predicted demand computing section S1 for computing a predicted demand U1 from a function U1=F1 (X1, X2, X3, X4, X5, X6, ...) when the center communication terminal receives present demand (X1) season (X2), day of the week (X3), time (X4), air temperature (X5), event schedule (X6), possible audience rating (X7) and so on, and a price determining section or means T1 for comparing the predicted demand with the power supply capacity to determine an electric power price. More particularly, if the predicted demand exceeds the power supply capacity, the power price is set to be relatively high. This is because the demand is prevented from exceeding the power supply capacity and also because if the demand is too high, the rate of heating in a power plant using coal and petroleum having increased unit costs for power generation is increased. On the contrary, if the predicted demand is lower than the power supply capacity, the power price is set to be relatively low so that a proper profit can be obtained by the electric power company. The determination of power price may be carried out for every thirty minute period.

When the power price is determined, a price signal outputting section or means T2 in the center communication terminal T outputs a power price signal containing the determined power price to each of the customer's communication terminals connected D1 to Dn to the center communication terminal. The fourth embodiment can be mainly applied to cases where the customers are provided with independent electric power plants. More particularly, each of the customer's communication terminals comprises a comparator section 201 for comparing the power price contained in the power price signal send from the center communication terminal T with the power generation cost of the independent power plant and for selecting any one of these which is advantageous for that customer. If the parameters in the above function include an additional parameter indicative of the amount of buying schedule on the customer side X8, this may have been previously reported to the center communication terminal through the customer's communication terminal of the customer to determine the demand schedule.

The fourth embodiment is advantageous in that it can provide the reduction of equipment and communication costs, in comparison with the first, second and third embodiments.

The fifth embodiment of the present invention is a combination of the first embodiment with the fourth embodiment. The fifth embodiment is adapted to execute the power distribution control cycles shown by the first and fifth embodiments alternately at given time intervals. More particularly, as shown in Fig. 4, the center communication terminal R comprises a predicted demand computing section S1, a computing section S2, a presentation signal outputting section S3, a selecting section S4, a selection signal outputting section S4, a price determining section T1 and a price signal outputting section T2. As shown in Fig. 5 , the center communication terminal R executes the outputs of a selection and price signals alternately to each of the customer's communication terminals. The fifth embodiment can more finely control the power distribution than the previous embodiments.

Alternatively, the fifth embodiment may alternately execute the controls of the second and fourth embodiments or the controls of the third and fourth embodiments.

Claims

1. A power distribution control system comprising a center communication terminal (S) and a plurality of customer's communication terminals (C1... Cn) operatively connected to said center communication terminal (S) through communication lines and to a group of loads,
said center communication terminal (S) comprising presentation signal outputting means (S3) for outputting a presentation signal containing a load reduction request time period and an incentive payment to each of said customer's communication terminals (C1...Cn) and selection signal outputting means (S5) responsive to response signals from said customer's communication terminals (C1...Cn) for outputting a selection signal or signals to one or more customer's communication terminals (C1...Cn) selected based on functions including parameters relating to the recuced quantity of power and reduction time period,
each of said customer's communication terminals (C1...Cn) comprising response signal outputting means (102) for outputting a response signal to said center communication terminal (S), said response signal containing the reduced quantity of power and reduction time period which are computed from the load reduction request time period, incentive payment contained in the presentation signal from said center communication terminal (S), and one or more potential of reduction and power

reduction means (103) for reducing the power supply to the group of loads for a given time period, based on the selection signal from said center communication terminal (S).

2. A power distribution control system according to claim 1, wherein each of the customer's communication terminals (C1...Cn) has an increased product of the reduced quantity of power times reduction time period.

3. A power distribution control system as defined in claim 1 wherein said selection signal outputting means (S5) of the center communication terminal (S) is adapted to output a selection signal containing the reduction time period, reduced quantity of power and incentive payment which are computed from the reduced quantity of power and reduction time period in the response signal from each of said customer's communication terminals (C1...Cn).

4. A power distributed control system as defined in claim 2 wherein said selection signal outputting means (S5) of the center communication terminal (S) is adapted to output a selection signal containing the reduction time period, reduced quantity of power and incentive wage which are computed from the reduced quantity of power and reduction time period in the response signal from each of said customer's communication terminals (C1...Cn).

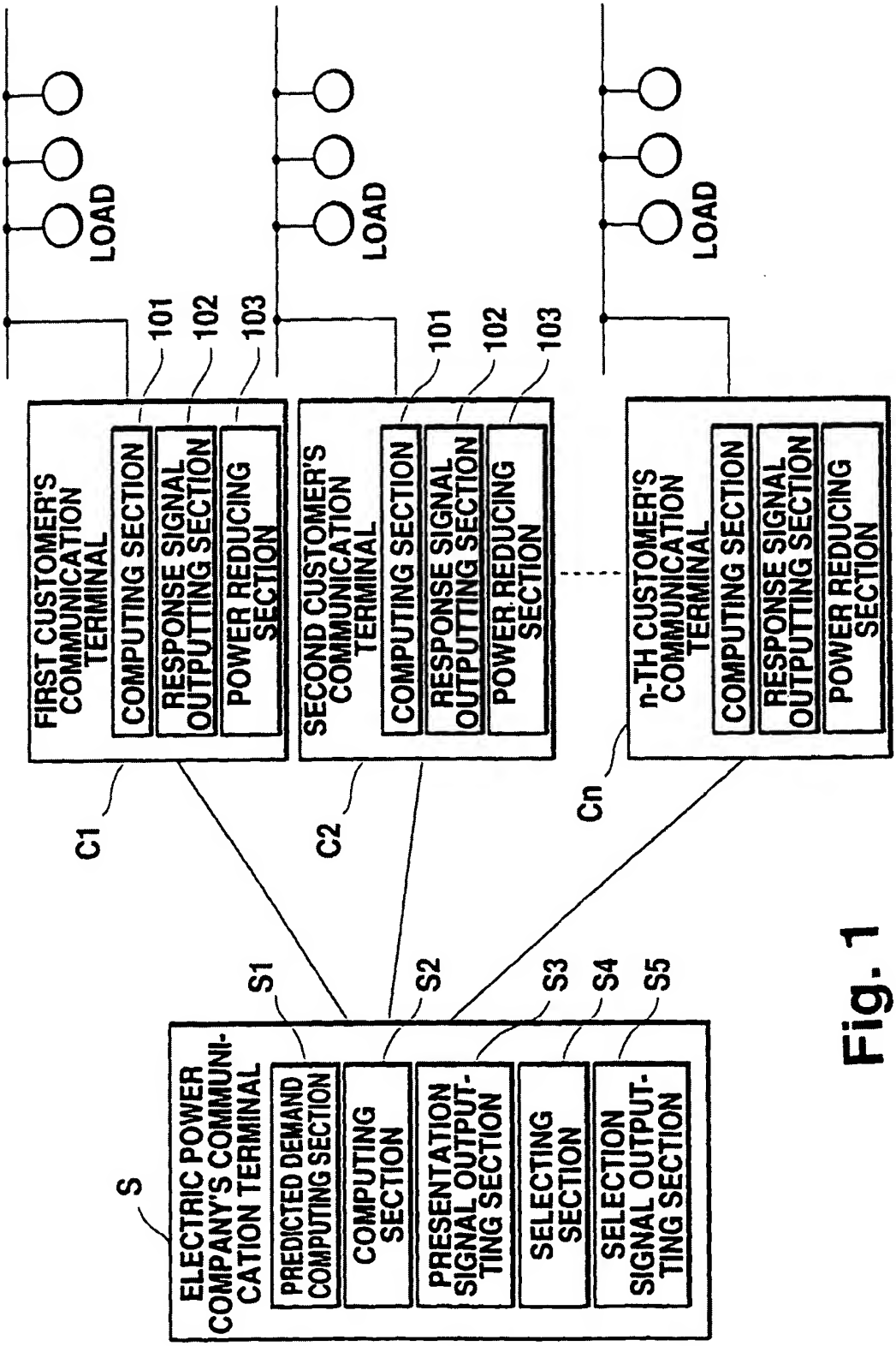
5. A power distribution control system comprising a center communication terminal (S) and a plurality of customer's communication terminals (C1...Cn) operatively connected to said center communication terminal (S) through communication lines and to a group of loads,
said center communication terminal (S) comprising presentation signal outputting means (S3) for outputting a presentation signal containing a load reduction request time period to each of said customer's communication terminals (C1...Cn) and selection signal outputting means (S5) responsive to response signals from said customer's communication terminals (C1...Cn) for outputting a selection signal or signals to one or more customer's communication terminals (C1...Cn) each of which has a reduced incentive payment,
each of said customer's communication terminals (C1...Cn) comprising response signal outputting means (102)) for outputting a response signal to said center communication terminal (S), said response signal containing an incentive payment computed from a load reduction request time period contained in the presentation signal and a plurality of reduction potentials, and power reduction means (103) for reducing the power supply to the group of loads for a given time period, based on the selection signal from said center communication terminal (S).

6. A power distribution control system comprising a center communication terminal (S) and a plurality of customer's communication terminals (C1...Cn) operatively connected to said center communication terminal (S) through communication lines and to a group of loads,
said center communication terminal (S) comprising presentation signal outputting means (S3) for outputting a presentation signal containing a load reduction request time period and selection signal outputting means (S5) responsive to response signals from said customer's communication terminals (C1...Cn) for outputting a selection signal or signals to one or more customer's communication terminals (C1...Cn) selected based on functions including parameters relating to the reduced quantity of power, reduction time period and incentive payment,
each of said customer's communication terminals (C1...Cn) comprising response signal outputting means (102) for outputting means (102) for outputting a response signal to said center communication terminal (S), said response signal containing the reduced quantity of power, reduction time period and incentive payment which are computed from the load reduction request time period contained in the presentation signal from said center communication terminal (S), and one or more reduction potential and power reduction means (103) for reducing the power supply to the group of loads for a given time period, based on the selection signal from said center communication terminal (S).

7. A power distribution control system comprising a center communication terminal (T) and a plurality of customer's communication terminals (D1...Dn) operatively connected to said center communication terminal (T) through communication lines and to a group of loads,
said center communication terminal (T) comprising predicted demand computing means (S1) for computing a predicted demand from a demand predicting potential, price determining means (T1) for comparing said predicted demand with a power supply capacity to determine an electric power price and price signal outputting means (T2) for outputting a power price signal containing the determined power price to each of said customer's communication terminals (D1...Dn).

8. A power distribution control system as defined in any of claims 1 to 6 wherein said center communication terminal (T) further comprises predicted demand computing means (S1) for computing a

predicted demand from a demand predicting potential, price determining means (T1) for comparing said predicted demand with a power supply capacity to determine an electric power price, and price signal outputting means (T2) for outputting a power price signal containing the determined power price to each of said customer's communication terminals (C1...Cn).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POWER REDUCING SECTION
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ELECTRIC POWER COMPANY'S COMMUNICATION TERMINAL
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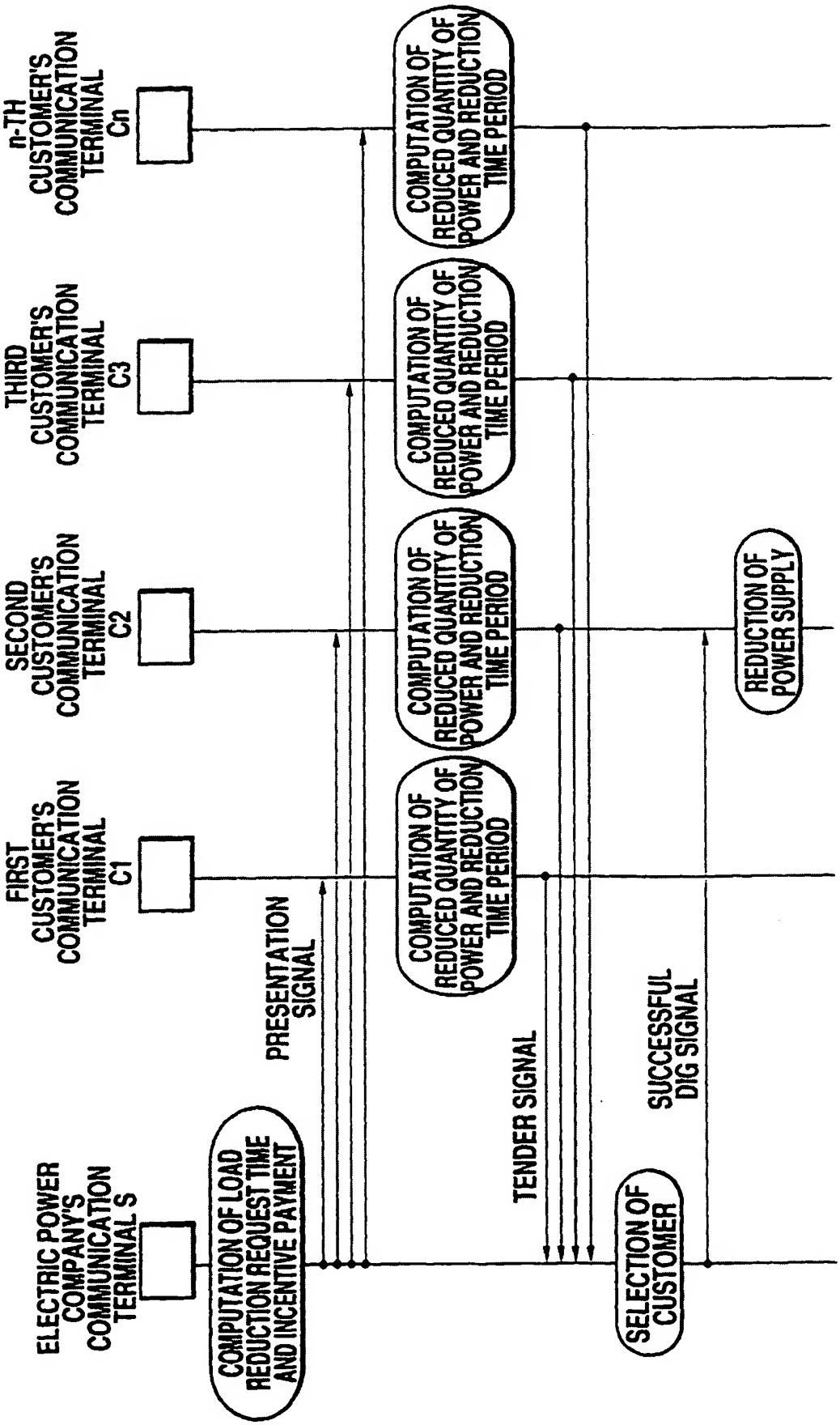
COMPUTING SECTION
PRESENTATION SIGNAL OUTPUTTING SECTION
SELECTING SECTION
SELECTION SIGNAL OUTPUTTING SECTION

Fig. 1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THIRD CUSTOMER'S COMMUNICATION TERMINAL C3
n-TH CUSTOMER'S COMMUNICATION TERMINAL Cn
COMPUTATION OF LOAD REDUCTION REQUEST TIME AND INCENTIVE PAYMENT
PRESENTATION SIGNAL
COMPUTATION OF REDUCED QUANTITY OF POWER AND REDUCTION TIME PERIOD
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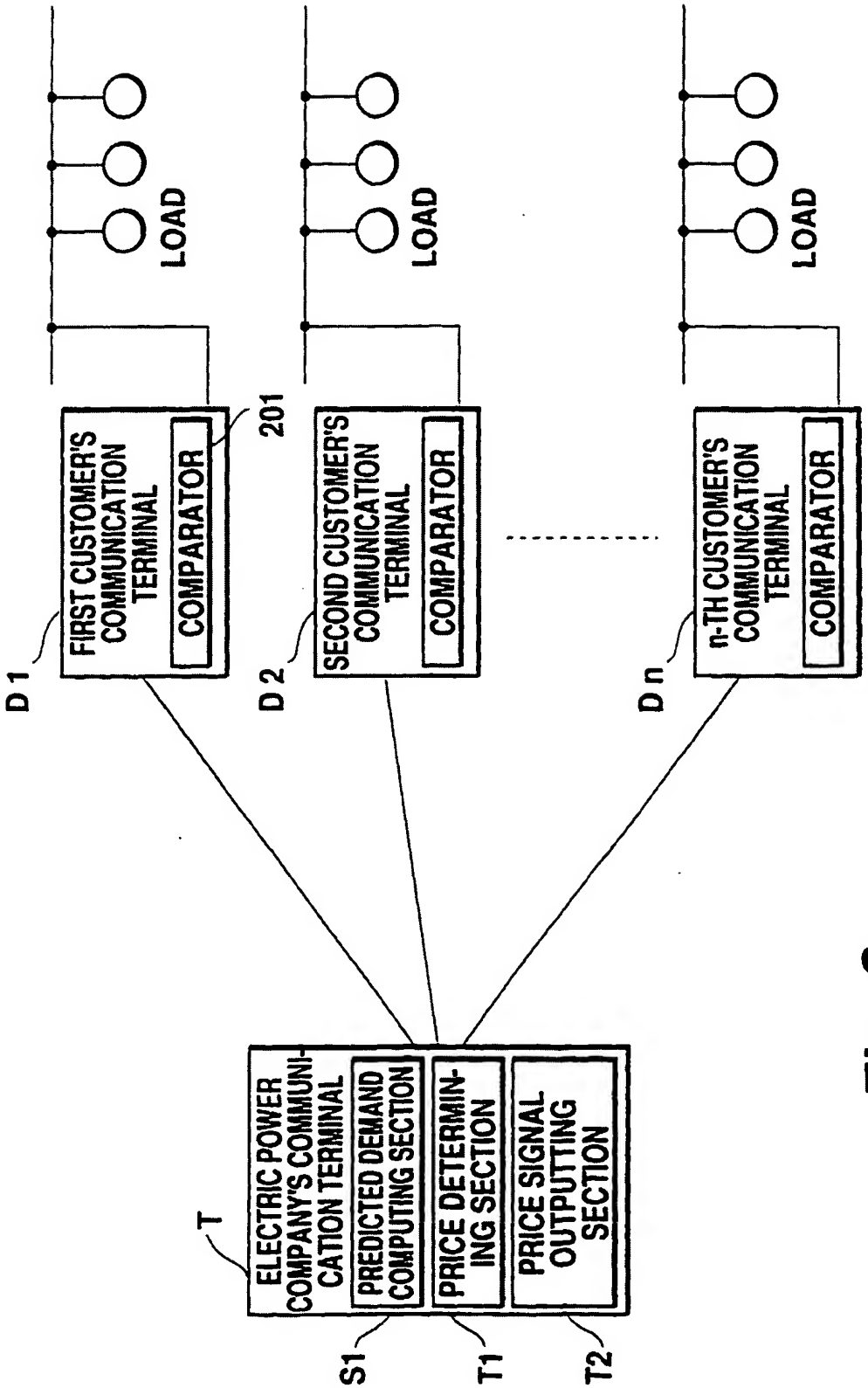
COMPUTATION OF REDUCED QUANTITY OF POWER AND REDUCTION TIME PERIOD
TENDER SIGNAL
SUCCESSFUL DIG SIGNAL
SELECTION OF CUSTOMER
REDUCTION OF POWER SUPPLY

Fig. 2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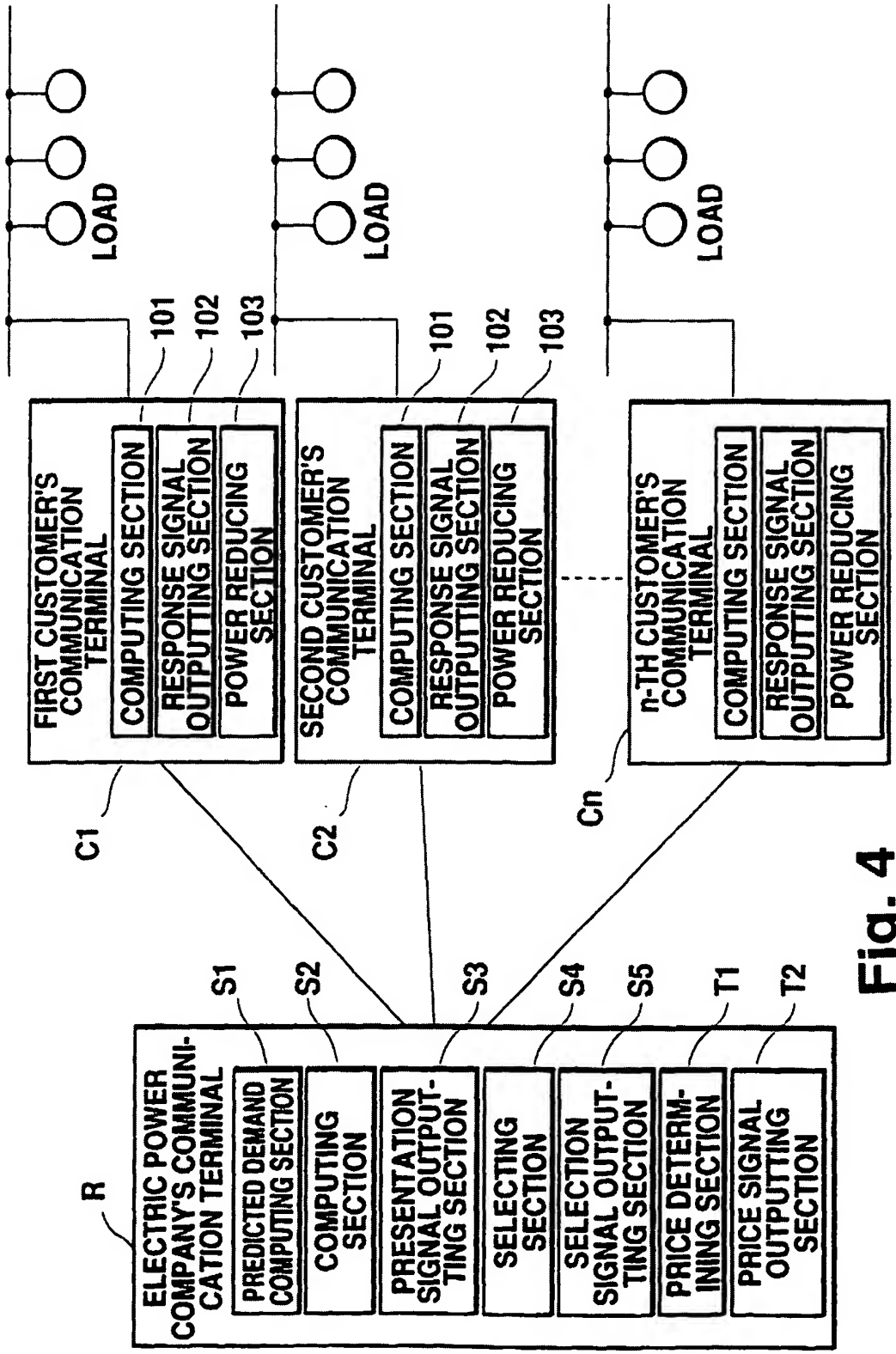
PRICE DETERMINING SECTION
PRICE SIGNAL OUTPUTTING SECTION
S1
T1
T2

Fig. 3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S5
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T2
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ELECTRIC POWER COMPANY'S COMMUNICATION TERMINAL
PREDICTED DEMAND COMPUTING SECTION
COMPUTING SECTION
PRESENTATION SIGNAL OUTPUTTING SECTION
SELECTING SECTION
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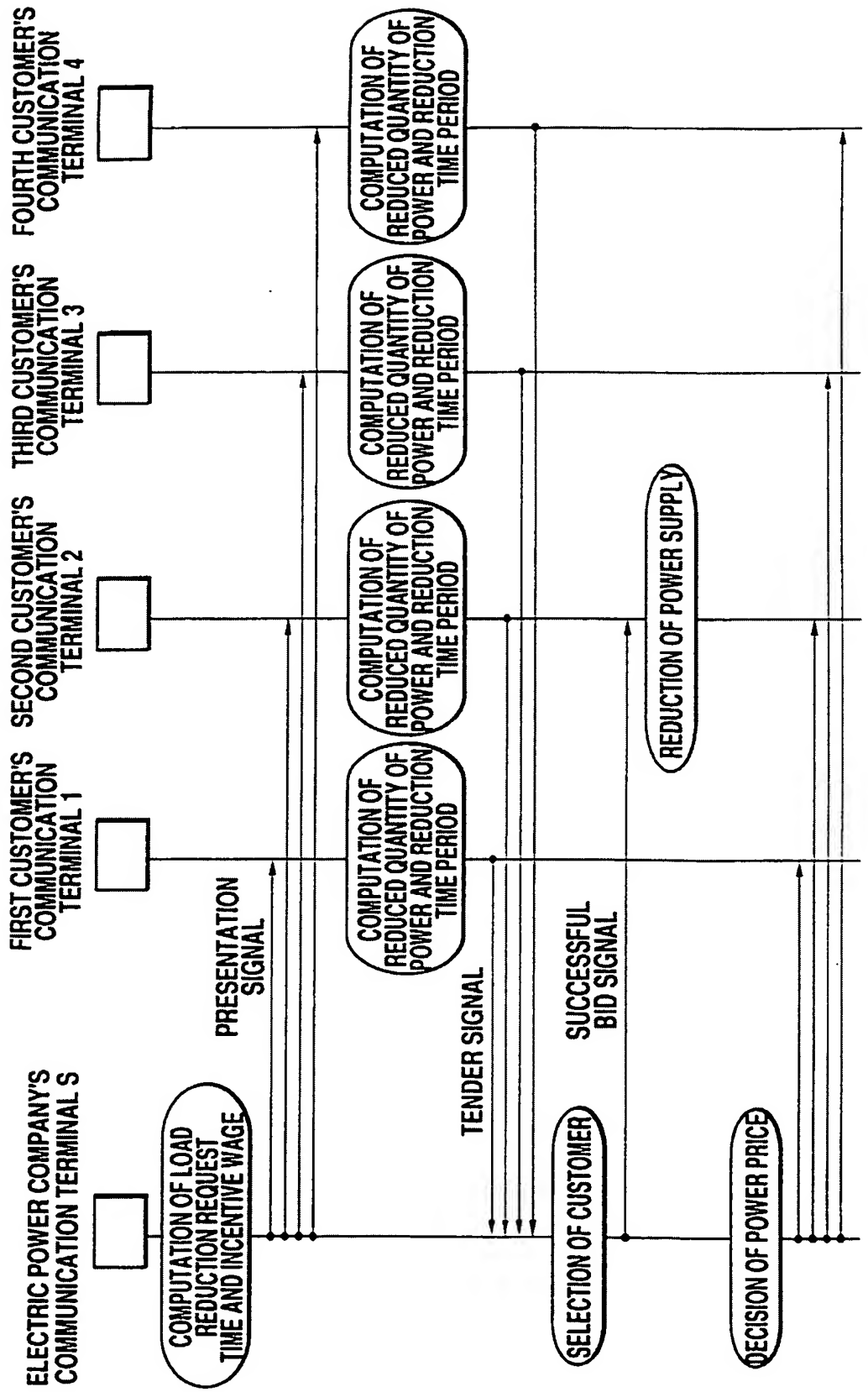
PRICE DETERMINING SECTION
PRICE SIGNAL OUTPUTTING SECTION

Fig. 4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COMPUTATION OF LOAD REDUCTION REQUEST TIME AND INCENTIVE WAGE
PRESENTATION SIGNAL
COMPUTATION OF REDUCED QUANTITY OF POWER AND REDUCTION TIME PERIOD
COMPUTATION OF REDUCED QUANTITY OF POWER AND REDUCTION TIME PERIOD
COMPUTATION OF REDUCED QUANTITY OF POWER AND REDUCTION TIME PERIOD
COMPUTATION OF REDUCED QUANTITY OF POWER AND REDUCTION TIME PERIOD
TENDER SIGNAL
SUCCESSFUL BID SIGNAL
REDUCTION OF POWER SUPPLY
SELECTION OF CUSTOMER
DECISION OF POWER PRICE

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 98114424.9

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	WO 89/12342 A1 (NIEDNER, P.) 14 December 1989 (14.12.89), page 7, line 16 - page 9, line 23, claims 1-3,12.	1,5,6	H 02 J 13/00 H 02 J 3/14
A	--	7,8	
Y	EP 0265342 A2 (SANGAMO WESTON, INC.) 27 April 1988 (27.04.88), column 4, line 53 - column 5, line 61, column 10, line 40 - column 11, line 25.	1,5,6	
Y	-- EP 0445448 A1 (MITSUBISHI DENKI K.K.) 11 September 1991 (11.09.91), column 6, line 16 - column 7, line 45.	1,5,6	
	----		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H 02 J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	08-10-1998	MEHLMAUER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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